

The deviation of man from the state in which he was originally placed by nature seems to have proved to him a prolific source of diseases.

Edward Jenner, *An Inquiry Into the Causes and Effects of the Variolæ Vaccinæ, or Cow-Pox* (1798)

HAZARDOUS WASTE

Pond Algae Sequester Strontium-90

Strontium-90 is a radioactive by-product of fission reactions within nuclear reactors that generate electricity. About 3% of the mass of spent nuclear fuel consists of fission products including strontium-90.¹ Because of its high decay energy and its long half-life of 30 years—it takes hundreds of years to decay naturally to harmless levels—strontium-90 is classified a high-level waste. Strontium-90 deposits in bone and bone marrow, and exposure from contaminated food and water is linked to bone cancer and leukemia.² Now Derk Joester, an assistant professor of materials science and engineering at Northwestern University in Evanston, Illinois, and his colleagues have found that common freshwater green algae sequester strontium into insoluble crystals, offering a possible way to separate strontium-90 from less hazardous components of nuclear waste.³

Closterium moniliferum, a ubiquitous bright green pond alga, forms crystals

composed of strontium, barium, and sulfate. The crescent-shaped algae store the crystals in tiny vacuoles. Barium is necessary for the organism to deposit strontium, and the Northwestern team found that varying the ratio of barium to strontium in water boosted the amount of strontium captured in crystals by a factor of up to 150.³ This enhanced the strontium selectivity of the process.

Nonradioactive strontium was used for the proof-of-concept laboratory experiments. Whether *C. moniliferum* tolerates radioactive strontium-90 needs to be determined, but the authors point out these organisms “have proven to be resistant to harsh environments such as extreme temperature, acidic pH, low nutrient availability, and light limitation.”³

C. moniliferum also prefers strontium to calcium. This is important because calcium, a harmless mineral, is found in nuclear waste along with strontium. Plants tested for bioremediation do not differentiate between strontium and calcium, so they become saturated with the latter simply because it is more abundant.⁴ But *C. moniliferum* does differentiate: “Algae avoid this problem by actively excreting calcium during crystal formation,” Joester says. He adds that algae potentially could become direct bioremediation agents, and

understanding how they lock up strontium could lead to better engineered microbes.

The Northwestern team envisions a filtration system where algae would precipitate crystals in hours or days. The crystals would be harvested, then incinerated to remove organic matter. The remaining concentrated crystals would be fused into glass blocks (“vitrified”) for safe storage, according to first author Minna Krejci, a Ph.D. candidate at Northwestern University.

Some nuclear waste is already vitrified,¹ but Joester says the sheer volume of nuclear waste makes it economically unfeasible to contain everything in glass blocks. The U.S. Department of Energy estimates the cost to process all radioactive waste currently stored in the United States at \$50 billion.⁵

“These results look very promising for the use of green algae for bioremediation,” says Belinda Sturm, an environmental engineer at the University of Kansas, Lawrence. However, algae grown for biofuels are expensive to harvest at large scale, and similar challenges may apply to algae that clean up nuclear waste. “This does not negate their potential but emphasizes the need for further study,” Sturm says.

If sequestration proves successful, algae may help to recover strontium-90 dispersed in oceans, lakes, or rivers after nuclear accidents, such as leaks from the Fukushima nuclear power plant in Japan.⁶ Perhaps algae could be designed to sink to the bottom, allowing strontium-90 to decay without entering the food chain, or floating algae could be skimmed off the surface and contained, suggests Roger Blomquist, principal nuclear engineer at Argonne National Laboratory.

Carol Potera, based in Montana, has written for *EHP* since 1996. She also writes for *Microbe*, *Genetic Engineering News*, and the *American Journal of Nursing*.

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C. moniliferum cell has deposited strontium-bearing barite crystals in the gray vacuole at the alga's tip.

Minna R. Krejci

AIR POLLUTION

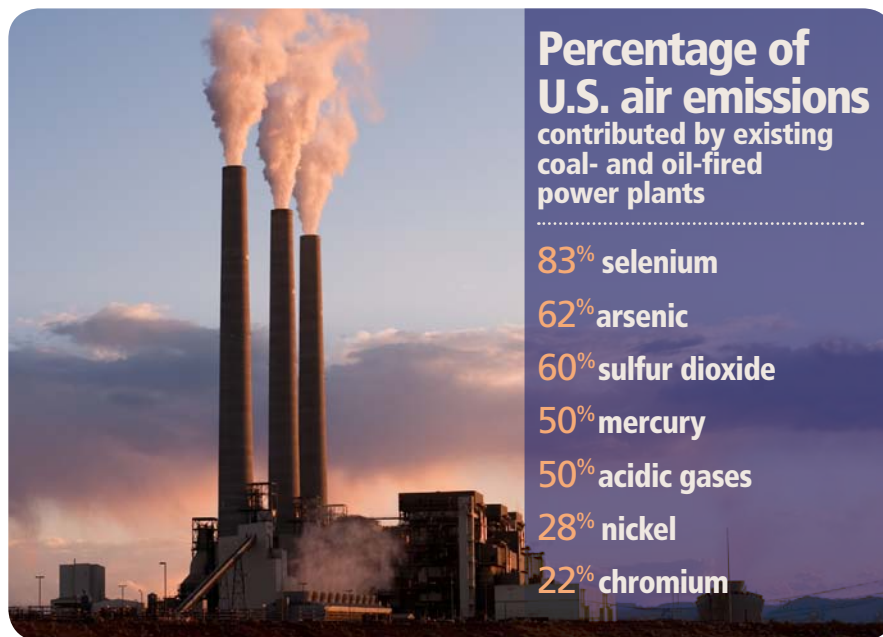
New Rules Proposed for Power Plant Toxics

Coal- and oil-fired power plants are key cogs in U.S. economic development. They're also major emitters of many toxic substances, including mercury, arsenic, chromium, and dioxins. In an effort to dramatically cut the latter while modestly impacting the former, the U.S. Environmental Protection Agency (EPA) is proposing regulations that would set the first national standards for emissions of toxic substances from about 525 power plants.^{1,2} The agency estimates that by 2016 the proposed standards, which would regulate 67 toxics, could produce health benefits worth \$5–13 (for avoided premature deaths, nonfatal heart attacks, respiratory problems, lost work days, and other health outcomes) for every \$1 spent to meet the requirements.¹ But Melissa McHenry, spokeswoman for American Electric Power, whose 25 coal-fired power plants serve 5.3 million customers in 11 U.S. states, says the agency is significantly underestimating costs to industry.

The new regulations, which are scheduled by consent decree to be finalized by 16 November 2011, would replace a George W. Bush administration regulation that addressed only mercury.³ In February 2008 the U.S. Court of Appeals for the District of Columbia vacated that regulation, deeming it inadequate under the requirements of the Clean Air Act.⁴

Among the toxics covered in the proposed rule for existing plants are mercury, lead, arsenic, chromium, cadmium, nickel, antimony, beryllium, manganese, hydrogen chloride (HCl), hydrogen fluoride (HF), dioxins, and furans. Additional sulfur dioxide (SO₂), nitrogen oxides (NO_x), and particulate matter (PM) standards would be implemented for new plants. The agency says existing plants, which are located in nearly every state and provide 46% of U.S. electricity generation, are responsible for 83% of all airborne selenium emissions, 62% of arsenic, 60% of SO₂, 50% of mercury, over 50% of many acid gases (including HCl and HF), 28% of nickel, and 22% of chromium.^{1,5}

The agency says existing technology⁶ could be used to meet all the proposed standards and that the installed equipment would concurrently reduce SO₂, NO_x, and PM even in existing plants for which such controls would not be mandated. As part of the new rules, the agency is also proposing



mandatory work practices that would lead to optimal combustion and subsequent reductions in toxics such as dioxins and furans.

When installed, the EPA estimates the new equipment and operating practices would keep 91% of the mercury in coal from being released into the air and reduce 91% of acid gases and 55% of SO₂ from power plants each year. The agency also predicts that implementing the controls will not only prevent 850,000 days of missed work each year but also provide 31,000 short-term construction jobs and 9,000 long-term utility jobs.⁷

Regarding the toxics parameters, McHenry says, “We don’t have a problem with the proposed limits.” But she is concerned about the time allotted by the EPA to implement necessary controls. Power plant owners and operators would have three years to comply after the regulations are finalized, with the possibility of an additional year in certain circumstances. That’s too tight, she says, especially if about 20% of all plants have to shut down rather than add emission controls, which is what she says the industry is estimating. She says those closures might make it difficult for the remaining plants to meet peak demands.

A 15 April 2011 press release issued by Southern Company, which has 4.4 million customers in four Southern states, quotes company head Thomas A. Fanning as saying, “As the CEO of a company that has installed more pollution controls than any other utility, I tell you that this cannot be done in three years.”⁸ Furthermore,

Southern Company spokeswoman Valerie Hendrickson says the toxicity limits may not be achievable.

The Clean Air Task Force, an advocacy group that worked to overturn the old rule, is continuing its review of the lengthy proposed rule prior to the public comment deadline of 5 July 2011. “I’m glad it’s as strong as it is,” says senior counsel Ann Weeks. “But the devil is in the details.”

Bob Weinhold, MA, has covered environmental health issues for numerous outlets since 1996. He is a member of the Society of Environmental Journalists.

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2. The rules pertain only to certain existing and new public and private coal- and oil-fired power plants, such as those that have a certain generating capacity, that generate electricity for sale to the public, and that distribute the energy through the national electric grid. Rules for about 200,000 smaller power sources that burn coal, oil, or biomass, or larger ones that burn coal or oil and sell less than one-third of each plant’s power to the national grid, had been finalized in February 2011, but on 16 May 2011 the EPA withdrew them for further consideration. The deadline for additional public comment is 15 July 2011.
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5. About 44% of existing plants have no advanced pollution control equipment, according to the EPA. Often this is because they were built decades ago and have not been upgraded.
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CHILDREN'S HEALTH

Coal Fire Emissions Curb Children's Growth

Putting more coal on the fire may help to keep off the chill, but it may not help your baby grow. New research found that the 3-year-old children of Czech families who reported using coal for indoor heating were shorter than those whose families used cleaner fuels.¹

Similar to cigarette smoke, the smoke of burning coal contains fine particles, carbon monoxide, benzene, polycyclic aromatic hydrocarbons (PAHs), sulfur dioxide, arsenic, and other toxicants.² "PAHs and particulate matter are associated with reduced intrauterine growth," explains Irva Hertz-Picciotto, a professor of public health sciences at the University of California, Davis, and senior author of the study. "Air pollution has been linked to smaller length and head circumferences at birth, and there is evidence that secondhand [tobacco] smoke can affect the stature of children." Putting the pieces together, she says she and her colleagues became interested in whether indoor coal burning—a common exposure scenario in many countries—might affect children's early postnatal growth.

To investigate this potential link, the researchers examined the height at 36 months of 1,105 Czech children whose mothers had been recruited into the Teplice Pregnancy Outcome Study launched by the Czech government with assistance from the U.S. Environmental Protection Agency. These families were then followed longitudinally in the Children's Health and Air Pollution Study; information was obtained from pediatricians about the children's health and growth at birth

and at 36 months, and the children's mothers responded to questionnaires to determine how families heated their homes, their children's exposure to secondhand tobacco smoke, and other lifestyle variables.

The researchers used the medical history data to determine height-for-age-and-sex *z* scores for the children in homes that did and did not use coal for indoor heating. "These scores reflect the difference between height-for-age-and-sex of a child compared with a reference population, with the units being standard deviations," Hertz-Picciotto explains. "The growth of a child with a negative score is below the mean for the reference population, and the lower the score, the poorer the growth."

Indoor coal combustion was used to heat 10.2% of the children's homes; of these, 77.6% used coal exclusively. The mean height-for-age-and-sex at 36 months for the children in these homes was significantly lower than that of children from non-coal-burning homes. In regression modeling, adjusting for confounders such as birth weight for gestational age and sex, maternal height, and maternal ethnicity, height-for-age-and-sex was found to be significantly associated with indoor coal combustion.

Translating the *z* scores into absolute height differences, 3-year-old boys from indoor coal-burning homes were a mean 1.34 cm shorter, while the girls were a mean 1.3 cm shorter, says first author Rakesh Ghosh, a postdoctoral scholar at UC Davis. "The results showed the effect to be compounded if children were [also] exposed to secondhand cigarette smoke," Ghosh says.

The link between respiratory disease in children and the indoor burning of solid fuels (including coal, wood, and dung) has long been known in the developing world, where homes

The Beat

by Erin E. Dooley

EU Herbal Product Regs Come into Force

On 1 May 2011 new regulations on herbal products came into force in the European Union (EU).¹ The regulations require that all products sold be assessed by the European Medicine and Healthcare products

Regulatory Agency to show they have been manufactured according to strict standards and contain a consistent and clearly marked dose. Each EU member state also is required to establish a registration scheme for manufactured traditional herbal medicines that are suitable for use without medical supervision. Products will only be sanctioned for use for minor medical problems, such as colds, muscular aches and pains, and sleep problems.

Canadian PM Says No to Ban on Asbestos Exports

In late April 2011 Canadian prime minister Stephen Harper said that country would not ban the export of asbestos, despite calls from scientists and health advocacy groups.² Harper cited concerns about market discrimination in defending the decision and pointed out the chrysotile form of asbestos "is permitted internationally under conditions of safe and controlled use,"² although several studies suggest truly controlled use

is impossible to achieve.³ Dozens of other countries have banned all forms of asbestos, a known human carcinogen, but the material is still widely used in developing countries, typically with few controls.³

BREATHE LA Launches Child Asthma Management Program in Port City

BREATHE LA, a nonprofit environmental public health advocacy organization, recently renewed its O24u environmental education and asthma management program in the city of Long Beach.⁴ More than 21% of the children in this port city have asthma. The O24u program trains facilitators in 36 Long Beach elementary schools to educate children and their parents about air pollution causes, effects, and asthma identification and management. BREATHE LA estimates the project could yield a 10–15% decrease in school absenteeism due to asthma and a \$2.7 million savings in avoided asthma-related emergency room visits and hospitalizations.



New EU regulations have taken many herbal remedies off store shelves.

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commonly have open hearths and no chimney. But this is the first time growth reduction has been associated with coal burning in the ventilated indoor hearths and furnaces of a developed country. Even with ventilated coal heaters, Hertz-Picciotto says there are two ways children can be exposed: first, when the coal is added, smoke and ash likely enter the room; and second, some fraction of the particles vented outdoors likely land nearby and circulate in areas near the house.

The World Health Organization describes the emissions from solid fuels as the “killer in the kitchen,” claiming them responsible for 1.5 million respiratory illness–related deaths every year, mostly in Southeast Asia and sub-Saharan Africa and predominantly affecting women and children.³ Some research

has also linked the use of such fuels to poorer growth in young children in developing countries,^{4,5} whereas other work has associated indoor coal use with increased lower respiratory tract illnesses.⁶

“The results provide an important public health warning for countries where coal is still burned indoors,” says study co-supervisor Radim Šrám of the Institute of Experimental Medicine AS CR, Prague, Czech Republic. “Moving to cleaner heating systems should be a priority, yet indoor coal use in some countries, such as China, is increasing.”

“It is difficult to disentangle the many influences on child development,” points out Martin McKee, a professor of European public health at the London School of Hygiene & Tropical Medicine, who was not involved with the study. “Many of them cluster together, so that families that are disadvantaged in one way may be exposed to many different hazards. As the authors note, they were unable to assess the extent to which children were exposed to coal smoke, [but nonetheless, this study] raises some important questions.”

Adrian Burton is a biologist living in Spain who also writes regularly for *The Lancet Oncology*, *The Lancet Neurology*, and *Frontiers in Ecology and the Environment*.

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Climate Change: Mastering the Public Health Role

The American Public Health Association (APHA) and the U.S. CDC have released a guidebook for public health practitioners on how to address climate change in their work. The guidebook summarizes a recent series of webinars that brought together climate and health experts and policy makers to discuss climate science, health risk communication, and climate adaptation strategies from a public health perspective.⁵ The guidebook, available for free on the APHA website,⁶ provides examples of how localities are already addressing climate-related health risks to ensure the effects are mitigated for vulnerable populations such as the elderly.

GreenChill Partnership Now Nationwide

Since 2007 food retailers participating in the U.S. EPA's GreenChill partnership have voluntarily agreed to adopt refrigeration



practices to reduce emissions of refrigerants that damage the ozone layer and contribute to the greenhouse effect.⁷ The agency recently announced the partnership now includes 7,000 partner stores across all 50 states, representing 20% of the supermarket industry.⁸ The U.S. EPA

estimates that emissions of refrigerants from partner stores are 50% below the industry average. Extensive best practice guidance at <http://www.epa.gov/greenchill/> advises retailers how to safely transition to new refrigerants, reduce the amounts of refrigerants used, and eliminate refrigerant leaks.

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